Nexus between homestead food garden programme and land ownership in South Africa: Implication on the income of vegetable farmers

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JEL Codes: Q18, O13

#106

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Keywords: Gross margin; homestead food garden programme; land redistribution; endogenous switching regression; propensity score matching; South Africa

JEL: I380, Q110, Q120, Q150, Q180

1. Introduction

Globally, increasing food production towards meeting the food needs of people, food security, safety, quality and nutrition present critical food policy issues that most economies are seeking to attain. This is a result of the fact that more than 600 million people across the globe do not have adequate access to quality food, predominantly in emerging economies (Sasson, 2012). Rapid increases in population and climate change are expected to put much stress on the food scarcity situation because it is projected that the world population will reach over 9 billion by the year 2050 (FAO, 2009). The increase in population requires substantial increases in food production. Meanwhile, with the current variations in climate, pressures are mounting on governments and policy makers to design, formulate and implement food policy interventions which are economically efficient and environmentally sustainable.

The South African government, in an attempt to address some of these relevant food policy issues, has implemented some food policy and development programmes aimed at increasing food production, reducing food insecurity, malnutrition and hunger, as well as improving the income and livelihood status of people, particularly among the rural poor. Among the policy interventions are the Agriculture and Land Reform Policy, the Comprehensive Agricultural Support programme, the Food Trade Policy, and the South Africa Integrated Food Security Strategy (SAIFSS) (DAFF, 2014). Given the colonial history of South Africa, the Agriculture and Land Reform Policy, as well as the South Africa Integrated Food Security Strategy (SAIFSS) (DAFF, 2014), are major food policy issues attracting much debate in South Africa. One of the key food policy interventions under the SAIFSS is the implementation of homestead food garden programmes.

The homestead food garden programme combines different physical, social, institutional and economic functions on an area of land owned by households and families to produce food commodities such as vegetables (Galhena et al., 2013). Advocates of homestead food gardening argue that the system is well adapted to local agronomic and resource conditions, and to cultural and food preferences. The homestead food garden programme is considered as being a more sustainable agricultural practice for improving food security, improving nutrition in rural areas, and enhancing economic growth (Galhena et al., 2013). Nkosi et al. (2014) has further argued that a food production system that is controlled by households is

more reliable and sustainable than nutrition interventions that primarily rely on government goodwill and financial support. Some authors have assessed the homestead food garden programme and found that the programme has significantly improved vitamin A intake among South African children, and supplemented household food consumption (Faber et al., 2002; Nkosi et al., 2014), as well as boosting nutritional security (Faber et al., 2011). Pandey et al. (2016) demonstrated that agricultural interventions, such as home gardens, enhance nutrient intake and nutritional outcomes in South Asia.

What has not been investigated is the extent and precise impact of the homestead food garden programme under the SAIFSS strategy on rural households' incomes in South Africa. Also, the causal effect of the homestead food garden programme and land ownership under the Agriculture and Land Reform Policy in South Africa has not been explored rigorously. To the best of our knowledge, no known study has explored the impact of the homestead food garden programme with particular emphasis on land ownership in the Southern African region. This study bridges this knowledge gap by rigorously examining the determinants and impact of the homestead food garden programme on gross margins of vegetable farmers in the Gauteng province of South Africa, using two parametric modelling techniques that account for selection bias, as well as evaluating the impact of the programme. Additionally, the present study explores the impact of participating in the homestead food garden programme under different systems of land ownership. Overall, the study provides relevant policy information required in the formulation and modifications of existing sustainable food policies and interventions which aim at reducing poverty, food insecurity, hunger and poverty, as targeted by the post-2015 development agenda for sustainable development goals.

2. Overview of homestead food garden programme and land ownership

The homestead food garden programme in the Gauteng province of South Africa came into existence in 1997 and was one of the projects identified as government's response to dealing with food insecurity, poverty, hunger and malnutrition. The programme also seeks to improve the income of households through sales of surplus production from homestead food gardens. The main aim of the programme was to ensure food security for everyone in the Gauteng province.

The homestead food garden programme targets the most vulnerable groups, namely the elderly, women, youth, people living with disability and HIV/AIDS, the unemployed and

military veterans in Gauteng's urban and peri-urban areas. This implies that participation in the programme is not randomised, and as such, an impact evaluation of such a programme requires adopting methodology that accounts for selection bias. The programme offers training on vegetable production and provides beneficiaries with production packages to enable them to produce food to feed their families and to sell surplus production to generate an income (Rudolph, 2012).

Specifically, beneficiaries receive some training on homestead food gardening, as well as starter packs, according to the Gauteng Food Security Standard of Operation Programme (SOP). The training takes a period of 3 working days. After successfully participating in the training, the starter packs are given to the participants (DACE, 2002). The package includes a spade, fork, rake, hand hoe, two (2) 30 dcm3 bags of compost, a 10-litre watering can, and six (6) types of seeds (spinach 10g, beetroot 10g, onion 7g, carrot 8g, beans 15g, and tomato 2.5g) (GADS, 2006). It is important to note that only one starter pack per household is given, even if more than one person from a household participates in the training programme. Beneficiaries of the programme attend meetings with the local leadership (ward councillors, ward committees, etc.) and the programme implementers to discuss the sustainability of the programme. One of the key issues that forms part of policy in the Gauteng province and other provinces is land redistribution. People receive land through either the South African Land Bank or the Department of Agriculture, Forestry and Fisheries (DAFF). Mostly, land is given to groups of farmers or cooperatives (Aliber et al., 2013). The quality of the individuals' proposals determines whether their applications for land will be successful or not. On average, individuals receive about 1 hectare, either below or above in extent (Aliber et al., 2013). Depending on the size of cooperatives and quality of proposals, about 10 hectares of land can be given, on average, for commercial farming purposes. In this study, we focused on individuals and not cooperatives.

The Department of Rural Development and Land Reform (DRDLR) is responsible for the country's land redistribution programme and is tasked with redressing the disparity in land ownership. This programme is a joint venture with the Department of Agriculture, Forestry and Fisheries (DAFF) (Treasury, 2014). The purpose of the national DRDLR is to create and maintain an efficient and sustainable land release, and to act as a catalyst for rural development to ensure rural livelihoods and standards of living are improved. It has

introduced reforms to improve access to land and to redress skewed ownership patterns. Land reform focuses on land restitution, tenure reform and land redistribution (Treasury, 2014).

3. Material and methods

3.1. Theoretical framework and empirical specifications

Households' decisions to participate in the homestead food garden programme are influenced by a number of personal, farming, socioeconomic and institutional factors, as well as the individual's perception about the benefits associated with the programme. Before a household will participate in the homestead food garden programme, they first gather background information about the programme by consulting extension officers and learning from other farmers, before and after participation (Genius et al., 2014). We denote the production function of the homestead food garden as:

$$y_i = f(P_i^v, W_i^w, H_i) \quad (1)$$

where y_i represents crop production; P_i^v is a vector of farm inputs such as weedicide, seed, fertilizer, and pesticides; W_i^w denotes irrigation water and H_i represents homestead food garden programme characteristics. Vegetable production (y_i) contributes significantly to households' food production and income, which in turn reduces food insecurity, hunger and poverty. In our theoretical framework, we assume that households' decisions whether or not to participate in the homestead food garden programme are informed by their expectations about the benefit of the programme in terms of contribution to food production, income and food security.

Households' decisions whether to participate in the homestead food garden programme or not depend on the benefits derived from participation, relative to non-participation. Based on this assumption, we denote the net benefit that farmer *i* derives from participating in the homestead food garden programme by δ_{PA} and the net benefit from non-participation in the homestead food garden programme as δ_{NP}. Households are expected to participate in the homestead food garden programme if the utility derived from it exceeds that of non-participation ($\delta_{PA} > \delta_{NP}$). This translates into a binary choice, which is examined using a binary choice model. The two choice scenarios are represented as:

$$\delta_{iPA} = Z_i \alpha_{PA} + \ell_{iPA} \quad (2)$$

$$\delta_{iNP} = Z_i \alpha_{NP} + \ell_{iNP} \quad (3)$$

where Z_i is a vector of the individual, household, farm-level, homestead food garden programme characteristics and perception, α_{PA} and α_{NP} are parameters to be estimated, ℓ_{iPA} and ℓ_{iNP} are random disturbance terms for participants and non-participants, respectively. The perceived net benefits of participating in the homestead food garden programme are not known to the researcher. Only the Z_i vector characteristics are known during the survey. However, we can represent the net benefit associated with homestead food garden programme participation by a latent variable Y_i^* expressed as a function of observable characteristics Z_i . Let the latent variable be expressed as:

$$Y_i^* = \lambda' X_i + \mu_i; \quad Y_i = 1[Y_i^* > 0] \quad (4)$$

where Y_i is a binary dependent variable that equals 1 for households that participate in the homestead food garden programme, and zero otherwise. λ is a vector of parameters to be estimated. μ is the error term with zero mean and constant variance. X is a vector of individual, household, farm-level, and homestead food garden programme characteristics, as well as perceptions on the homestead food garden programme. However, explanatory variables, such as extension contacts and non-farm work, are likely to be endogenous to homestead food garden programme participation (Koundouri et al., 2006; Abdulai and Huffman, 2014). Hence, we addressed the potential endogeneity problem by expressing the variables as functions of all other exogenous variables in the participation equation (4), plus a set of instruments (Koundouri et al., 2006). This is specified as:

$$\Upsilon_{ij} = \lambda' X_i + \gamma I_{ij} + \xi_i; \quad j = 1, 2 \quad (5)$$

where Υ_{i1} denotes a binary variable for extension contacts and Υ_{i2} is a binary variable for off-farm work participation, X is defined above, and I_i represents the set of instruments that is correlated with the endogenous variables, but uncorrelated with the error term (μ) in equation (4), and as such it is not included in the estimation of the homestead food garden programme participation equation (4). The homestead food garden programme participation equation is re-specified as:

$$Y_i^* = \beta' X_i + \omega_1 \Upsilon_{i1} + \omega_2 \Upsilon_{i2} + \varphi_1 R_{i1} + \varphi_2 R_{i2} + \nu_i \quad (6)$$

where X_i is as defined above, Υ_{i1} is the observed extension contacts and Υ_{i2} is the observed off-farm work, R_{i1} and R_{i2} represents the residual terms obtained from the first-stage equation explaining determinants of extension contacts and off-farm work participation, respectively. Since farmers take into consideration the expected outcome of their choice of participation in homestead food garden programme, their choice of homestead food gardening should be considered when analysing net returns or gross margins in order to avoid selection effect (Pitt, 1983). The selectivity effect will cause households whose productivities are below average to shun participating in the homestead food garden programme, given the fixed factors. This will truncate the distribution of observed benefits arising from the homestead food garden programme. Theoretically, this occurs when the error terms of the participation (ν) and outcome equation (ℓ) are correlated $\left(corr(\nu, \ell) = \rho\right)$. This is usually caused by unobserved factors. When the unobserved factors are determined, policy interventions can be implemented to deal with them, while promoting households' participation in the homestead food garden programme, while improving food production and security.

According to Abdulai and Huffman (2014), when the unobserved factors are not captured in estimations, an ordinary least estimation procedure will yield biased estimates. Attributing yield difference to participation in the homestead food garden programme is difficult in cross-sectional surveys since there is no information on counterfactual effects (Dehejia and Wahba, 2002). However, a propensity score matching (PSM) approach has been extensively employed to account for the impact of farmers' participation in policy interventions or technology adoption on farm productivity in situations where self-selection bias is not a problem (Amare et al., 2012). The propensity score estimation procedure stabilises the observed distributions of covariates across the group of participants and non-participants. This means that the probit estimates cannot be regarded as determinants of adoption. In order to use the probit estimates as determinants, Lee (1982) proposed an endogenous switching regression approach which accounts for selection bias. We adopted the endogenous switching regression model (Lee, 1982) to account for selection bias in this paper. The endogenous switching regression model accounts for unobserved variables by considering selectivity as an omitted variable problem (Heckman, 1979). Since gross margins in our study are observed for homestead food garden programme participants and non-

participants, the switching regression model categorises households into participants and non-participants in order to capture the differential response of the two sub-samples. If the household chooses to participate in the programme, the observed net benefits take the form:

$$\psi_{iPA} = Z_i'\alpha_{PA} + \ell_{iPA} \text{ if } Y_i = 1, \text{ otherwise } \psi_{iNP} = Z_i'\alpha_{NP} + \ell_{iNP} \text{ if } Y_i = 0, \quad (7)$$

where ψ_{iPA} and ψ_{iNP} are the outcome variables for homestead food garden programme participants and non-participants, respectively, Z' is a vector of farmer, farm and household, as well as programme, characteristics. The vectors α in equation (7) and λ in equation (4) are associated parameters to be estimated. However, it must be emphasised that variables in vectors *Z* in equation (5) and *X* in equation (6) may overlap, and it is worth noting that proper identification requires that at least one variable in *X* does not appear in Z. Farmers' perception about the benefits of the homestead food garden programme was used as the exclusion variable in our estimations (Abdulai and Huffman, 2014; Waglin and Abdulai, 2016). Abdulai and Huffman (2014) indicated that the perception of farmers does not directly influence farm yield and net returns. However, it can significantly influence farmers' participation decisions. Therefore, this variable was excluded from the outcome equations. In such instances, self-selection into the participants or non-participant categories may result in nonzero covariances between the error terms of the participation decision equation and the outcome equation. Therefore, the error terms ν, ℓ_{PA} and ℓ_{NP} are assumed to have a trivariate normal distribution, with mean vector zero and the following covariance matrix:

$$\text{cov}(\ell_{PA}, \ell_{NP}, \nu) = \sum = \begin{bmatrix} \delta^2_{PA} & \delta_{PN} & \delta_{P\nu} \\ \delta_{PN} & \delta^2_{NP} & \delta_{N\nu} \\ \delta_{P\nu} & \delta_{N\nu} & \delta^2_{\nu} \end{bmatrix} \quad (8)$$

where $\text{var}(\ell_{PA}) = \delta^2_{PA}$, $\text{var}(\ell_{NP}) = \delta^2_{NP}$, $\text{var}(\nu) = \delta^2_{\nu}$, $cov(\ell_{PA}, \ell_{NP}) = \delta_{PN}$, $cov(\ell_{PA}, \nu) = \delta_{P\nu}$ and $cov(\ell_{NP}, \nu) = \delta_{N\nu}$. Under this scenario, the ℓ_{NP} and ℓ_{PA} in equation (7) have nonzero expected values which are conditional on the sample selection criterion. Hence, OLS estimates of α_{PA} and α_{NP} are affected by sample selection bias (Lee, 1982). Hence, Johnson and Kotz (1970) argued that the errors terms should be truncated and are given as:

$$E(\ell_{NP} / Y = 0) = E(\ell_{NP} / \nu \leq -x'\lambda) = \delta_{N\nu} \frac{-\phi(x'\lambda / \theta)}{1 - \vartheta(x'\lambda / \theta)} = \delta_{N\nu}\gamma_{NP} \quad (9)$$

$$E(\ell_{PA} / Y = 1) = E(\ell_{PA} / \nu > -x'\lambda) = \delta_{P\nu} \frac{-\phi(x'\lambda / \theta)}{\vartheta(x'\lambda / \theta)} = \delta_{P\nu}\gamma_{PA} \quad (10)$$

where ϕ and ϑ denote the probability density and cumulative distribution functions, respectively. γ_{PA} and γ_{NP} are inverse Mills ratios of ϕ and ϑ evaluated at $x'\lambda$. Inverse Mills ratios are integrated into equation (7) to cater for bias in selection.

Two stage models are estimated jointly through a Full Information Maximum Likelihood (FIML) approach in order to avoid a heteroskedasticity problem (Lokshin and Sajaia, 2004). Thus, the participation and outcome equations are estimated simultaneously. A probit model is first estimated to determine the selectivity terms $(\gamma_{PA}, \gamma_{NP})$. The signs and significance of the correlation coefficients (ρ) from the simultaneous estimations are very relevant. Endogenous switching is observed when either $\rho_{PA_\nu}(\delta_{PA_\nu} / \delta_{PA}\delta_\nu)$ or $\rho_{NP_\nu}(\delta_{NP_\nu} / \delta_{PA}\delta_\nu)$ is statistically significant. Negative selection bias occurs when $\rho > 0$, implying that households whose gross margins are below average are more likely to participate in the homestead food garden programme. If $\rho < 0$, then there is positive selection bias, indicating that households whose gross margins are above average are more likely to participate in the programme. In this paper, particular attention and interest is given to the impact of participating in homestead food garden programme on household gross margin. We first assessed the expected values of households' gross margin. For a homestead food garden programme participant with characteristics Z and X, the expected gross margin, δ_{1PA} is specified as:

$$E(\psi_{PA} / Y = 1) = Z_1\alpha_{PA} + \delta_{PA_\nu}\gamma_{PA} \quad (11)$$

The last term ($\delta_{PA}\gamma_{PA}$) accounts for sample selection. It explains whether households who participate in the homestead food garden programme may act differently from an average household with similar characteristics. Assuming that the same household did not participate in the homestead food garden programme, then equation (11) is specified as:

$$E(\psi_{NP} / Y = 0) = Z_0\alpha_{PA} + \delta_{PA_\nu}\gamma_{NP} \quad (12)$$

The difference between participation (11) and non-participation (12) is denoted as the change in gross margin due to homestead food garden programme participation. This

estimate is referred to as average treatment effect on the treated (ATT) (Smith and Todd, 2005). This average treatment effect estimates from the endogenous switching regression (ESR) gives an unbiased estimate of participation effects. To examine the counterfactual imaginary scenarios that the non-participants did participate and the participants did not participate is the difference between equations (13) and (14):

$$E(\psi_{NP} / Y = 0) = Z_0 \alpha_{NP} + \delta_{NP_v} \gamma_{NP} \quad (13)$$

$$E(\psi_{iNP} / Y = 1) = Z \alpha_{1NP} + \delta_{NP_v} \gamma_{PA} \quad (14)$$

Assuming that there is no selection bias arising from unobservable factors, propensity score matching (PSM) was used to estimate the impact of the homestead food garden programme on gross margin. The propensity score matching technique compares the outcomes of homestead food garden programme participants (treated) and non-participants (controlled). The observed characteristics of the treated and controlled groups should be similar in order to minimize the bias, which may have occurred if the two groups are entirely dissimilar (Dehejia and Wahba, 2002). We first generated the propensity score of participating in the homestead food garden programme using a probit model. Secondly, the average treatment effect on the treated (ATT) based on the predicted propensity scores was estimated. The propensity score matching is specified as:

$$\Pr(Z_1) = \Pr(Y_1 = 1 / X_1) = E(Y_1 / X_1) \quad (15)$$

where $Y_1 = \{0,1\}$ gives an indication whether the household participated in homestead food garden programme and X_1 represents the characteristics of the homestead food garden programme. The average treatment effect of the treated ψ_{ATT}^{PSM} can be specified as:

$$\psi_{ATT}^{PSM} = E[\psi_{iPA} / Y = 1] - E[\psi_{iNP} / Y = 1] = X(\alpha_{iPA} - \alpha_{iNP}) + (\delta_{PA_v} - \delta_{NP_v})\gamma_{PA} \quad (16)$$

The nearest neighbour (NNM) kernel-based (KBM) and Radius matching algorithms were employed to estimate the average treatment effect on the treated (ATT). These methods are the most-widely used techniques in recent literature to estimate the average treatment effect of the treated (ATT) (Waglin and Abdulai, 2016).

3.2. *Data and sampling*

The multi-stage sampling technique was employed in this study. In the first stage, the Gauteng province was chosen because it was among the provinces that had benefited from the homestead food garden programme. The second stage involves the random selection of five municipalities in the province using balloting. The municipalities selected are Johannesburg, Tshwane, Ekurhuleni, West Rand and Sedibeng. Seventy-seven (77) households were randomly chosen from Johannesburg, 78 from Tshwane, 103 from West Rand, 131 from Ekurhuleni, and 111 from Sedibeng, based on rural household populations in each municipality. In total, 500 rural farmers were selected, comprising 234 participants in the homestead food garden programme and 266 non-participants. The survey data were collected in 2015 from the rural households using a structured questionnaire. The first part of the questionnaire solicited information regarding yield, revenue, costs, the homestead food garden programme, asset endowments, and institutional, farm and socioeconomic characteristics related to the households.

4. Results and discussion

4.1. Summary characteristics of variables used in the analysis

Table 1 presents the summary characteristics of the variables used in the model. We tested whether there were significant mean differences in the variables for participants and non-participants. For dummy variables, the mean multiplied by one hundred will give the proportion of each category. The results show that 46.8 % (234) of the respondents were participants of the homestead food garden programme, whereas 53.2 % (266) were non-participants. The average gross margin for participants of the homestead food garden programme was ZAR21 279.15 per hectare in a production season, whereas that of non-participants was ZAR14 026.12 per hectare. The statistical test of difference in means reveals that there is a highly significant mean difference of ZAR7 253.03 between homestead food garden programme participants and non-participants. This suggests that the gross margin of non-participants of the homestead food garden programme is 51.71 % lower than that of participants. However, this mean difference may confound the impact of participating in homestead gardens on gross margin with other unobserved factors. Hence, this cannot be relied on as the real impact of the homestead food garden programme on gross margin of vegetable farmers (Abdulai and Huffman, 2014). It must be emphasised that gross margin

was used because there were no reliable data on fixed capital for sampled respondents, and as such was it was neglected.

Table1: Summary characteristics of variables used in the models.

Variable	Description	Participants N= 234	Non-participants N=266	Mean difference
Outcome variable				
Gross margin	Revenue less input costs per hectare	21279.15 (785.94)	14026.12 (118.09)	7253.03 ***
Independent variables				
Household characteristics				
Age	Age of farmer in years	47.12(9.00)	41.30(8.11)	5.82***
Education	Years of formal education	10.55(3.11)	13.51(2.33)	-2.96***
Household size	Household number	5.23(0.75)	3.07(0.70)	2.16***
Gender	1 if female, 0 otherwise	0.66(0.48)	0.62(0.50)	0.04
Employment	1 if household head is employed, 0 otherwise	0.69(0.49)	0.79(0.29)	-0.10
Off-farm activity	1 if respondent engages in off-farm activity	0.65(0.50)	0.70(0.30)	-0.05
Income	Monthly income (ZAR)	3872.56 (655.48)	7815.17 (159.89)	-3942.61 ***
Farm characteristics				
Land size	Size of farm land (Ha)	0.75 (0.57)	0.58(0.19)	0.17
Distance	Distance from farm to market (km)	4.66 (0.12)	2.09 (0.97)	2.57**
Market access	1 if household has access to market, 0 otherwise	0.56(0.49)	0.48(0.27)	0.08
Hired labour	1 if household employed hired labour, 0 otherwise	0.69 (0.54)	0.58(0.32)	0.11
Irrigation access	1 if household has access to irrigation system, 0 otherwise	0.49(0.19)	0.17(0.26)	0.32***
Fertilizer use	1 if household uses chemical fertilizer, 0 otherwise	0.61(0.46)	0.32(0.42)	0.29**
Institutional characteristics				
Extension	1 if household has access to extension services, 0 otherwise	0.57 (0.42)	0.43(0.47)	0.14
Credit access	1 if household has access to formal credit, 0 otherwise	0.52 (0.32)	0.69 (0.12)	-0.17***
Support	1if household has access to government support, 0 otherwise	0.89(0.43)	0.63(0.11)	0.26***
Social network	1 if household has social network with other farmers,0 otherwise	0.75(0.21)	0.40 (0.09)	0.35***
Household assets				
Livestock	1 if household owns livestock, 0 otherwise	0.61(0.49)	0.69 (0.30)	-0.08
Livestock value	Value of livestock in ZAR	28172.61 (255.48)	27915.17 (359.89)	257.44
Implements value	Value of implements in ZAR	22833.83 (311.34)	31088.89 (381.09)	-8255.06 ***
Percep_index	Households' perception about homestead food garden program	2.99	1.83	1.16**

(1=Poor; 2=satisfactory ; 3=Good)

*'**'*** denote 10%, 5% and 1% significant levels respectively.

The mean ages of homestead food garden programme participants and non-participants are about 47 and 41, respectively. There is a significantly positive mean difference of about 6 years. This implies that older people are more likely to participate in the homestead food garden programme, compared with younger people. Homestead food garden programme participants, on the average, have received 11 years of formal education, compared with non-participants who have had 14 years of formal education, with a significant mean difference of about -3 at 1 % level. The mean household sizes of participants and non-participants are 5 and 3, respectively. This implies that non-participants have significantly smaller household sizes, compared with participants. The results further show that females dominate in home food gardening, as 66 % and 62 % of the respondents are participants and non-participants, respectively. About 65 % of participants participate in off-farm activity, compared with 70 % of non-participants. The mean monthly income of homestead food garden programme participants and non-participants are about ZAR2 3872.56 and ZAR7 815, respectively. The significant mean difference shows that non-participants receive about ZAR3 942.61 more than participants do.

The mean farm land areas available to homestead food garden programme participants and non-participants are 0.75 and 0.58 hectares, respectively. This indicates that participants have about 0.17 hectares of land more than non-participants have. The average distances from home to market is 4.66 and 2.09 kilometres, respectively, for participants and non-participants. About 56 % of participants have access to market, compared with 48 % of non-participants. About 69 % of participants relied on hired labour for farming, compared with non-participants, where 58 % used hired labour. Most participants have access to irrigation systems, compared with non-participants, as 40 % of participants had access to irrigation, relative to 17 % for the non-participants. A significant mean difference of 0.32 was observed for access to an irrigation system at 1 % level. We found that 61 % of homestead food garden programme participants use nitrogen fertilisers, relative to 32 % of non-participants. About 57 % of homestead food garden programme participants have access to extension services, relative to 43 % of non-participants. On average, 52 % of the participants had access to credit, relative to 69 % for the non-participants, giving a significant mean difference of -0.17, suggesting that non-participants have greater access to formal credit.

About 89 % of the homestead food garden programme participants have access to other government support in a form of social grants, relative to 63 % of non-participants.

Also, 75 % of participants belong to farmer associations, compared with 40 % of non-participants. The significant mean difference indicates that homestead food garden programme participation facilitates a farmer's social capital. There is no significant mean difference relating to ownership of livestock. The results show that 61 % and 69 % of participants and non-participants own livestock, respectively. Homestead food garden programme participants and non-participants have livestock valued at ZAR22 833.83 and ZAR31 088.89, respectively. In terms of value of farm implements, non-participants have ZAR8 255.06 more than participants of the homestead food garden programme do. The perception index for homestead food garden programme participation is high (2.89) among participants, compared with non-participants (1.23). This implies that participants have higher strong perceptions towards the benefits of homestead food garden programme, compared with non-participants.

4.2. Empirical Results

4.2.1. Determinants of households' participation in homestead food garden programme

The empirical results for the two-stage endogenous switching regression model estimated for homestead food garden programme participation and its impact on gross margins are presented in Table 2. The results for the selection equation (column 2) are the determinants of households' participation in the homestead food garden programme. The estimates are interpreted as normal probit coefficients. The results show that education is significantly negative. This suggests that a unit increase in education will reduce the likelihood of households participating in the homestead food garden programme by 0.031, signifying that less-educated households are likely to participate in the programme. This is contrary to the findings of Huffman (2001). This may be attributed to the fact that people that are more educated tend to look for more formal or office work.

Table 2: Two stage endogenous switching regression estimates for participation and impact of homestead garden program on gross income of vegetable farmers

Variable	Selection	Gross margin	
		Participants	Non-participants
Constant	2.584*** (0.841)	3.508*** (0.527)	2.086**(0.921)
Age	-0.449 (0.281)	0.197** (0.090)	−0.156 (−0.136)

Education	-0.031*** (0.008)	3.555* (1.842)	4.267** (1.782)
Household size	0.892**(0.393)	1.759***(0.150)	1.934***(0.142)
Gender	0.068*** (0.018)	0.323***(0.102)	0.204*(0.111)
Employment	-0.477 (0.366)	3.242*** (0.337)	1.237*** (0.133)
Off-farm activity	-0.033***(0.009)	0.137** (0.066)	0.207*(0.107)
Income	0.229***(0.082)	0.150***(0.056)	0.177***(0.068)
Land size	0.355*** (0.016)	0.183***(0.063)	0.247***(0.071)
Market access	0.482(0.308)	2.342***(0.423)	3.761**(1.478)
Distance	1.091 (0.912)	-3.271*** (0.569)	-3.423*** (0.800)
Hired labour	-0.685** (0.274)	-0.363*** (0.095)	-0.449 *(0.269)
Irrigation access	8.572*** (2.243)	0.214** (0.095)	0.183* (1.74)
Fertilizer use	1.244 (0.909)	0.222**(0.100)	0.162** (0.064)
Extension	1.013**(0.413)	0.023 (0.059)	0.159 (0.111)
Credit access	0.035** (0.015)	3.347*** (0.419)	2.698** (0.328)
Support	0.031***(0.009)	0.122(0.112)	0.132(0.129)
Social network	0.224**(0.093)	0.170(0.126)	-0.118(0.077)
Livestock	0.345***(0.103)	4.840** (1.819)	3.918* (2.006)
Livestock value	0.779 (0.488)	0.939**(0.397)	0.387**(0.157)
Implements value	-0.771*** (0.263)	1.356***(0.400)	1.783***(0.344)
Perception	1.403***(0.130)		
Residual-off-farm-activity	0.233(1.002)		
Residual-extension	1.019(0.990)		
LR test of independence	105.78***		
Log likelihood	-121.96		
Chi -square(overidentification)	0.563 (0.47)		
Lns0			-0.544***(0.079)
Lns1		-1.638***(0.077)	
ρ_{NP}			-0.342(0.278)
ρ_{PA}		0.199***(0.027)	

Note: ***'**'* denote 1%, 5% and 10% significant levels.

The gender variable was found to be significantly different from zero and positive, suggesting that females are more likely to participate in the homestead food garden programme, compared with males. This means that females dominate in participation in homestead food gardens. This finding concurs with that of Galhena et al. (2013) who revealed that women dominate the informal agricultural systems such as home gardens, whereas men tend to dominate formal agricultural systems. We found that the engagement in off-farm activities reduces households' participation in the homestead food garden programme by 0.033 at 5 % level. This may be attributed to the fact that non-farm activities may be restricting the allocation of labour and time to work in the homestead food garden. Households' income significantly and positively influences their participation in homestead food garden programme at 1 % level. This suggests that as the incomes of household's

increase, their willingness to participate in the programme also increases, all things being equal.

In terms of farm characteristics, households who own large areas of land have a higher likelihood to participate in the homestead food garden programme. This is indicated by the highly significant coefficient for the land size variable. Households who rely on hired labour are less likely to participate in the homestead food garden programme. Households who have access to irrigation facilities are more likely to participate in the homestead food garden programme, all things being equal. This might be because vegetable production in homestead food gardens requires water, especially given the current changes in rainfall patterns attributable to climate variability. Households that apply chemical fertiliser are more likely to participate in the homestead food garden programme, as shown by the significantly positive coefficient estimate for the fertiliser use variable. This is in line with the findings of Abdoulaye and Sanders (2005).

Regarding institutional factors, the results show that access to extension services has significantly positive influence on households' participation in the homestead food garden programme. This means that households with extension contacts have a higher probability of participating in homestead food gardening. This finding provides the rationale for improvement in the extension agent-to-farmer ratio. Household access to credit is significantly different from zero and positive, showing that households who are not credit constrained are more likely participate in the homestead food garden programme. This finding concurs with that of Kassie et al. (2011). This highlights the relevance of credit access in facilitating farmers' participation in livelihood improvement interventions. Households that receive other support from the government besides homestead food garden programme support are more likely to participate in the programme, as shown by the highly significant coefficient for the support variable. Households with social networks with other farming households are more likely to participate in the homestead food garden programme, as shown by the highly significant and positive coefficient for the social network variable. This supports earlier findings by Bandiera and Rasul (2006) who asserted that farmers who have connections with other farmer groups have access to information, which tends to positively influence their decision to participate in sustainable farming practices and interventions.

The results further show that ownership of livestock increases households' participation in the programme by 0.345. This implies that households who own livestock are more likely to participate in homestead food gardening. This might be attributable to the fact that these households have access to manure from the animals which can be used in fertilising the vegetables and hence enhances their participation in vegetable production. Also, households who have more valuable farm implements are less likely to participate in the homestead food garden programme. It is worth noting that households' decisions to participate in the homestead food garden programme are highly dependent on their perceptions of the benefits associated with the programme.

4.2.2. Impact of homestead food garden participation on gross margin of vegetable farmers

The effects of household, farm and institutional characteristics, as well as household assets, on gross margin of both participating and non-participating homestead food garden vegetable farmers are presented in the last column of Table 2. The results show that farmers' age impacts positively on gross margin of participants of the homestead food garden programme. This implies that experienced farmers who participate in the programme obtain higher gross margins, relative to non-participants. Education has a positive effect on the gross margin of both participant and non-participant vegetable farmers, as indicated by the significantly positive coefficient estimates for both categories of farmers, a finding which concurs with Aubert et al. (2013). Household size is significantly different from zero and positive for both participants and non-participants in terms of gross margin. This means that as the household sizes of participants and non-participants increase, their gross margins also increase, ceteris paribus. This might be a result of the fact that households with large sizes, particularly in instances where household members are grown and assist on the farm, are able to increase their production due to availability of family labour. The gross margins of female participants and non-participants of the homestead food garden programme are significantly higher, compared with males. This is shown by the significantly positive coefficient of the gender variable. This concurs with the findings of Galhena et al. (2013). The gross margin of respondents who are formally employed is significant and positive for both participants and non-participants of the homestead food garden programme, as indicated by the significantly positive coefficient estimates for the employment variable for both categories of respondents. Engagement in off-farm activities has positive effect on the gross margins of both

participating and non-participating vegetable farmers. This might be might be due to the reason that vegetable farmers who participate in off-farm activities are able to generate income, which in turn helps them to procure inputs for their vegetable production. Household income was found to be significantly different from zero and positive for both participants and non-participants. This suggests that an increase in a household's income increases the gross margin of vegetable production, all things being equal.

Land size has a significantly positive influence on the gross margin of participating and non-participating vegetable farmers, as indicated by the significantly positive coefficient estimate for the land size variable. This implies that an increase in land owned by the participating households has the tendency to increase the gross margin of participants, and as such, distribution of land to participants of the programme should be given much attention. Access to market significantly impacts on gross margin of both categories of vegetable farmers, positively. However, we found that the longer the distance to the market, the lower the gross margins of both participants and non-participants of the homestead food garden programme. This implies that for achieving an increase in gross margin of vegetable farmers, satellite (spot) markets could be established around the vegetable producing area in order to reduce costs of transportation. Both participants and non-participants of the homestead food garden programme who use hired labour receive less gross margins, relative to those who use family labour. This may be due to the high cost incurred in hiring labourers. For instance, there are situations where the farmers have to buy food for labourers, beside their wages. The use of chemical fertilizer and access to irrigation facilities enhances gross margins of both participating and non-participating vegetable farmers. This highlights the need for vegetable farmers to be supported with inputs like fertilizer and irrigation facilities.

Access to credit has significantly positively effects on gross margins of both participating and non-participating vegetable farmers. This suggests that access to credit enhances the gross margins of vegetable farmers, whether they participate in the homestead food garden programme or not. This in line with the findings of Kassie et al. (2011) who found credit as a significant factor that enhances farmers' income. It is worth noting that ownership of livestock is significantly positive for both categories of vegetable farmers in terms of gross margin, suggesting that ownership of livestock has the potential to increase the gross margins of vegetable farmers. This means that vegetable farmers should be encouraged to keep livestock as part of the vegetable farming business. Finally, we found that the higher

the value of livestock and farm implements is, the higher the gross margin among both categories of vegetable farmers is. This implies that value of livestock and implements is directly related with gross margin, all things being equal.

The residuals of off-farm activity and extension were not significantly different from zero, at the conventional levels of significance. This shows that our estimations were consistent. The test statistics reveal that the equations are dependent, as indicated by the significant likelihood ratio tests for joint independence. The positive sign for ρ_{PA} implies that there is negative selection bias, which means that vegetable farmers whose gross margins are below average are more likely to participate in the homestead food garden programme. The insignificant ρ_{NP} statistic implies that, without participation in the homestead food garden programme, both groups of vegetable farmers would behave similarly, on average (Lokshin and Sajaia, 2004).

4.2.3. Impact of the homestead food garden programme on gross margin: endogenous switching regression (ESR) and propensity score matching (PSM) estimations

The average treatment effects of homestead food garden programme participation and ownership of land on gross margin of vegetable farmers are presented in Table 3. We estimated average treatment effect using the endogenous switching regression (ESR) method because the significant covariance term (ρ_{PA}) for homestead food garden programme participants indicated that there is selection bias arising from unobserved factors. The ESR accounts for both observable and unobservable factors and hence aids in attaining unbiased treatment effects. The results show that participation in the homestead food garden programme tends to increase the gross margin of vegetable farmers by 41.99 per cent, when non-participants of the programme were treated as the control group.

Table 3: Average treatment effect of homestead food garden programme participation on gross margin: ESR

	Mean outcome		ATT	*t*-Value	% change
	Participants N= 234 (46.80%)	Non-Participants N=266 (53.2 %)			
Gross margin (ZAR)	21989.15	15486.09	6503.06	10.76***	41.99

Land size > 1 hectares N=175(35%)

Gross margin (ZAR)	29745.55	21586.10	8159.45	19.96***	37.80
Land size < 1 hectares N=325(65%)					
Gross margin (ZAR)	20553.11	15586.55	4966.56	19.96***	31.86

Source: Authors' calculation, 2016
Note: *** indicates significance at 1% levels

This finding suggests that the promotion of farmers' participation in the homestead food garden programme can be beneficial to households' welfare by increasing their income, which in turn will reduce poverty and hunger, particularly among the rural poor farmers. The propensity score matching (PSM) technique was also employed to estimate the average treatment effect of homestead food garden programme participation on gross margins of vegetable farmers, assuming that there is no selection bias arising from unobservable factors, and the results are presented in Table 4.

Table 4: Average treatment effect of homestead food garden programme participation on gross margin: PSM

Matching algorithm	Mean outcome		ATT	*t*-Value	% change
	Participants N= 234 (46.80%) (Treated)	Non-Participants N=266 (53.2 %) (Controlled)			
Nearest neighbour matching (NNM)					
Gross margin (ZAR)	21569.15	15486.16	6082.99	10.04***	39.28
Kernel-based matching (KBM)					
Gross margin (ZAR)	21689.10	15076.11	6612.99	16.99***	43.86
Radius					
Gross margin (ZAR)	21899.10	15156.01	6743.00	18.11***	44.49
Land size > 1 hectares N=175(35%)					
Nearest neighbour matching (NNM)					
Gross margin (ZAR)	28744.50	18885.75	9858.75	20.11***	52.20
Kernel-based matching (KBM)					
Gross margin (ZAR)	29774.50	19085.43	10689.07	21.11***	56.01
Radius					
Gross margin (ZAR)	29899.81	18559.18	11340.63	25.11***	61.11
Land size > 1 hectares N=325(65%)					
Nearest neighbour matching (NNM)					
Gross margin (ZAR)	20989.77	15509.89	5479.88	19.01***	35.33
Kernel-based matching (KBM)					
Gross margin (ZAR)	20974.70	15075.43	5899.27	19.06***	39.13
Radius					
Gross margin (ZAR)	20744.50	14345.50	6399.00	19.44***	44.61

Source: Authors' calculation, 2016
*** denotes 1% significant level.

The results generally indicate that participation in the homestead food garden programme exerts a positive and statistically significant impact on gross margins of vegetable farmers in South Africa. More precisely, participation in the homestead food garden programme significantly increases the gross margin of vegetable farmers by 39.28 to 44.49 per cent, using the nearest neighbour, kernel-based and radius matching methods. Comparing the average treatment on the treated from the ESR and the PSM, we found that, without accounting for selection bias resulting from both observable and unobservable factors, the precise impact of homestead food garden programme participation on household income will be undervalued.

4.2.4. Impact of the homestead food garden programme on the gross margins of farmers with different land sizes: ESR and PSM estimations

The results on average treatment effects for homestead food garden programme participants and non-participants with land sizes below and above 1-hectare reveal that there are significant differences in gross margins. For the ESR estimations for vegetable farmers who own more than 1 hectare of land, the results show that the homestead food garden programme participants attain ZAR8 159.45 more than their non-participating counterparts do. The causal effect of participating in the homestead food garden programme is an increase in gross margin by 37.80 per cent for vegetable farming households who own above 1 hectare of farm land. For the ESR estimations for vegetable farmers who own less than 1 hectare of farm land, the results indicate that the causal effect of participating in the homestead food garden programme is an increase in gross margin by 31.86 per cent. The above results mean that participation in the homestead food garden programme has positive impact on the income of vegetable farming households who own either above or below 1 hectare. However, it is imperative to note that the gross margins per hectare for vegetable farmers who own more than 1 hectare of farm land are noticeably higher than those who own less than 1 hectare of farm land are. For instance, the gross margin for the homestead food garden programme participants and non-participants who own above 1 hectare of farm land are ZAR21 586.10 and ZAR8 159.45, relative to their counterparts who own less than 1 hectare of farm land with gross margins of ZAR15 586.55 and ZAR4 966.56, respectively.

From the PSM estimations for vegetable farmers who own more than 1 hectare of land, the results indicate that the causal effect of participating in the homestead food garden

programme is an increase in gross margin from 52.20 % to 61.11 %, using the Nearest neighbour, Kernel-based and Radius matching principles.

Regarding the gross margin for farmers who own less than 1 hectare of farm land, the findings reveal that the causal effect of participating in the homestead food garden programme is an increase in gross margin from 35.33 % to 44.61 %, using the same matching principles. Consistent with the ESR estimates, we found that the gross margins from the PSM for vegetable farmers who own more than 1 hectare of farm land are higher than those who own less than 1 hectare of farm land are. The above results suggest that the household vegetable production is very productive and economically efficient among households who own more land, especially among households who own more 1 hectare of farm land. These findings provide the rationale for homestead food garden programme implementers to consider land distribution and ownership in their programme implementation policies. The estimated propensity score presented in the Appendix shows that 86.66 % of the sample observations were correctly predicted.

5. Conclusions

Our empirical findings from the endogenous switching regression reveal the presence of selectivity effects for impact of participating in the homestead food garden programme on the gross margin of vegetable farmers in South Africa. The intuition drawn from this finding is that there will be sample selection bias if the outcomes of the programme are assessed without considering vegetable farmers' participation decisions. Therefore, it is imperative for policy analysts who are interested in knowing the precise impact of such policy interventions to factor in selectivity effects by employing impact evaluation approaches that account for selection bias. We conclude that there exists negative selection bias in homestead food garden programme participation and that the homestead food garden programme favours vegetable farmers whose gross margins are below average. This suggests that the programme favours the farmers with low incomes and this is in line with the government's objective of reducing poverty among the poor, while increasing food production, consumption and food security. Our findings from the ATTs indicate that participation in the homestead food garden programme can significantly enhance the welfare of participants by increasing their gross margins. Given the significant increase in income from participating in the homestead food garden programme, we recommend that government, development partners and policy makers should encourage more people to participate in the programme. It is further suggested

that the programme could be adopted by other Southern African Development Communities (SADC) as an important food policy intervention, which can improve the livelihoods of the poor.

More importantly, we conclude that the land redistribution policy implemented by the government appears to have significant impact on vegetable production and gross margin of vegetable farmers. We therefore conclude that secure tenure in land ownership has significant implications on the income of rural households in South Africa. Therefore, we suggest that the distribution of farm land under the agriculture and land reform policy should be accompanied with food policy programmes such as the homestead food garden programme and also that the willingness of people to participate in farming should be paramount to the land redistribution policy. Otherwise, the redistribution of farm land to people who are not ready to farm will be meaningless.

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Appendix

Propensity score estimates for households' participation in homestead food garden programme

Variable	Coefficient	Standard error	z-values
Constant	-1.997	1.883	1.06
Age	-0.059	0.050	1.18
Education	-1.018**	0.394	2.58
Household size	1.462**	0.656	2.23
Gender	0.987**	0.423	2.33
Off-farm activity	-5.332 **	2.672	2.00
Income	0.276**	0.112	2.46
Land size	0.553**	0.281	1.97
Distance	0.130	0.118	1.10
Market access	0.247	0.189	1.31
Hired labour	-1.088	1.321	0.82
Irrigation access	0.788***	0.241	3.27
Fertilizer use	0.434	0.291	1.49
Extension	0.886***	0.143	6.20
Credit access	0.594***	0.108	5.50
Support	0.775***	0.113	6.86
Social network	1.027***	0.193	5.32
Livestock	2.134*	1.223	1.74
Livestock value	-0.021	0.112	0.19
Implements value	-0.479	0.411	1.17
Pseudo-R^2	0.454		
Log-Log likelihood	-126.68		
Correctly classified	86.66%		
Observations	500		

Source: Authors' calculation, 2016

*, ** and *** indicates significance at 10%, 5% and 1% levels